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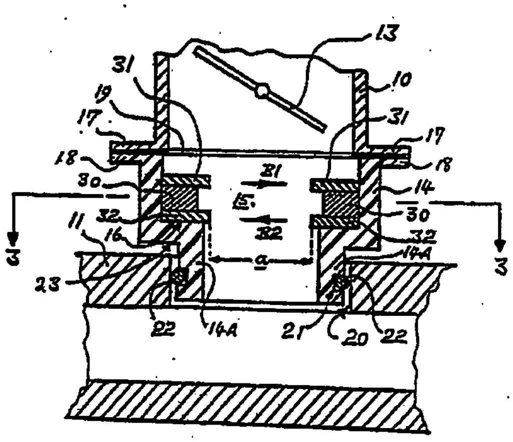

(57) Abstract

Improved combustion of fuel in an internal combustion engine is achieved by passing the air/fuel mixture being supplied to the engine through a pair of magnetic fields (B1, B2). The first magnetic field (B1) is applied at right angles to the flow direction of the air/fuel mixture. The second magnetic field (B2) is applied after the first magnetic field, also at right angles to the flow direction of the air/fuel mixture, but in the opposite direction to the first magnetic field. The effect of this sequential application of opposed magnetic fields is to reduce the number of large fuel droplets in the air/fuel mixture and increase the number of smaller droplets, thus creating an air/fuel mixture which burns more efficiently, to reduce the hydrocarbon and carbon monoxide contents of the exhaust gas of the engine. Apparatus to apply the magnetic fields is mounted between the outlet (10) of the carburattor or central fuel injector of the engine, and the inlet manifold (11) of the engine. Preferably the magnetic fields are established by magnet assemblies comprising a bar magnet (30) to which pole pieces (31, 32) are attached, mounted on either side of a channel (15) within a body member or housing (14).

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TITLE: MAGNETIC TREATMENT OF AIR/FUEL MIXTURE

Technical Field

This invention concerns the combustion of hydrocarbons. More particularly it concerns the combustion of petrol (also known as gasoline) in an internal combustion engine or in other gaseous fuel burning appliances where petrol and oxygen-containing gas are supplied to the other appliance as an aerosol mixture. In an internal combustion engine, such a supply of an air/fuel mixture occurs when a carburettor or fuel injector is used to control the supply of fuel to the engine.

Background to the Invention

In an ideal internal combustion engine, all of the fuel is burnt to produce carbon dioxide, water and heat. In practice, it is not possible to produce such an ideal engine, primarily because the kinetics of combustion in an internal combustion engine do not permit a sensible amount of energy to be extracted from complete combustion of a hydrocarbon fuel.

Pollution caused by the exhaust gases of internal combustion engines has been recognised for many years as a major environmental issue. The presence of the lead anti-knocking compounds in the petrol (gasoline) fuel used for many years is a well-known source of toxic lead-containing compounds in the atmosphere. Exhaust gases from motor vehicles not fitted with pollution control equipment also contain what are now regarded as

unacceptably high concentrations of hydrocarbons, carbon monoxide and oxides of nitrogen.

To reduce this pollution, a number of countries have introduced legislation requiring emission-control equipment to be used with all new internal combustion engines. For example, in Australia legislation enacted several years ago has required all new motor vehicles to be powered by lead-free or unleaded petrol. In addition to the requirement for new engines to be powered by unleaded petrol, maximum emissions of hydrocarbons, carbon monoxide and oxides of nitrogen have also been specified in Australian motor vehicle design rules.

Currently in Australia, new cars using unleaded petrol as their fuel have to be fitted with catalytic converters to meet the emission control requirements. However, it is generally recognised that catalytic converters and other pollution-reducing devices detract from the power available from an internal combustion engine. In an effort to improve the power available from engines while keeping noxious emissions to a minimum, most engine manufacturers have adopted fuel injection systems to introduce fuel into the cylinders, instead of carburettors. With unleaded fuel, engines having fuel injected systems still require a catalytic converter to remove the by-products of incomplete combustion by burning them in the presence of a catalyst if they are to comply with the emission control requirements.

Catalytic converters are expensive items of equipment. If a significant improvement in fuel combustion could be

obtained within the engine, to provide essentially complete combustion of the fuel, the exhaust gases should meet the emission control requirements. In such a situation, the catalytic converter could be removed. That would result in a considerable saving in the cost of the engine and a more efficient engine would be produced.

Another aspect of engine performance which has received considerable attention over recent years is fuel economy. Most petrol engine manufacturers have improved the design of their engines to reduce the volume of fuel required to drive a motor vehicle while maintaining satisfactory performance as far as power and engine torque are concerned. A number of these engine developments use improved combustion of the petrol fuel to improve the fuel economy of the engine.

Disclosure of the Present Invention

It is a prime object of the present invention to provide an internal combustion engine in which the fuel is burnt more efficiently, to reduce the volume of hydrocarbons, carbon monoxide and oxides of nitrogen in the exhaust gas of the engine. It is expected that in some instances, use of the present invention will result in the engine meeting the emission control requirements of the Australian Motor Vehicle Design Rule No 37/00 without a catalytic converter being used in the exhaust system of the engine. It is also expected that, in most instances, use of the present invention will result in an improved fuel economy of the engine.

This objective is achieved in an internal combustion engine equipped with a carburettor by subjecting the air/fuel mixture leaving the carburettor to the influence of magnetic fields. In the case of an engine equipped with a central fuel injection system, the air/fuel mixture injected directly into the inlet manifold of the engine is subjected to the influence of magnetic fields. In each case, the air/fuel mixture is passed through a first magnetic field having its magnetic lines of force substantially at right angles to the direction of flow of the air/fuel mixture. Then, after a short period where no magnetic field is applied to it, the air/fuel mixture is passed through a second magnetic field which has its magnetic lines of force at right angles to the direction of flow of the air/fuel mixture and in the opposite direction to the lines of force of the first magnetic field. Preferably the strength of the magnetic fields is constant. However, each magnetic field may be cyclically varied in strength.

When the present invention was first conceived, the inventor was uncertain of the mechanism that caused the improved combustion. It was known that air/fuel mixtures are essentially a suspension of fuel droplets in the carrier gas (air), and the present inventor hypothesised that when the very small globules (droplets) of fuel in the air/fuel mixture are subjected to such opposed magnetic fields, the globules were stressed and the inter-molecular or intra-molecular bonds of the fuel are ruptured, to produce an aerosol which contains a large number of extremely small, possibly monomolecular, globules of the

hydrocarbon fuel, or of lighter fractions of the hydrocarbon fuel. Such an air/fuel mixture would enable the fuel (or its fractions) to burn substantially completely during the power stroke of the internal combustion engine.

Some scientists felt this hypothesis was unrealistic. However, it is now known that the effect of the present invention is to reduce, substantially, the droplet size of the air/fuel aerosol, thus permitting more efficient combustion of the fuel.

Thus, according to the present invention, a method of treating the air/fuel mixture (consisting of droplets of fuel in suspension in the air) being supplied to an internal combustion engine to reduce the size of the face droplets in the mixture comprises the steps of

(a) subjecting the air/fuel mixture to a first magnetic field which has its magnetic lines of force extending substantially transverse the direction of flow of the air/fuel mixture, and

(b) subsequently subjecting the air/fuel mixture to a second magnetic field which has its magnetic lines of force substantially transverse the direction of flow of the air/fuel mixture and also substantially in the opposite direction to the lines of force of the first magnetic field, said pair of first and second magnetic fields being spaced apart from each other.

As indicated above, the strength of each magnetic field will normally be constant in value, but it may be cyclically varied.

In various implementations of the present invention, the magnetic fields have been established by two magnet assemblies each having a block or rod magnet with its magnetisation extending transverse the rod, between two elongate faces thereof. A pair of flat, soft-iron "pole pieces", each having a face with dimensions greater than the aforementioned elongate faces of the block or rod magnet, are clamped by the magnetic force derived by the rod magnet to the elongate faces of the rod magnet to provide elongate pole pieces extending from the rod magnet at right angles to its direction of magnetisation. These two assemblies are used on opposite sides of the channel in which direction of flow of the air/fuel mixture flows, to establish the first and second magnetic fields of the present invention.

The distance between the elongate faces of the block or rod magnet of each magnet assembly, and hence the separation of the pole pieces providing the first and second magnetic fields, is normally between 5 mm and 10 mm, and is preferably about 6 mm when the present invention is used in a 4-cylinder internal combustion engine of a motor vehicle. The separation between the pole pieces of the opposed magnet assemblies can vary from 10 mm to about 30 mm, but is preferably in the range from 10 mm to 20 mm.

The two magnet assemblies are mounted within a body member which is used to define part of the channel through which the air/fuel mixture flows.

Thus the present invention also provides apparatus for applying a pair of magnetic fields to an air/fuel mixture being supplied to an internal combustion engine, said apparatus comprising:

(a) a body member having a channel extending therethrough, said body member being adapted to be mounted on the engine to form part of the flow path of the air/fuel mixture; and

(b) a pair of magnet assemblies mounted within said body member in diametrically opposed relationship to the channel extending therethrough, said magnet assemblies producing (i) a first magnetic field having its lines of force extending in a direction which is transverse the channel and orthogonal to the flow-through direction in said channel of said air/fuel mixture, and (ii) a second magnetic field having its lines of force extending in a direction which is transverse the channel and opposite to the direction of the lines of force of said first magnetic field.

Preferably the magnet assemblies are as indicated above.

The magnets used in the present invention must have a high Curie temperature (the temperature at which their remanent magnetisation reduces to zero), so that the magnetic fields established by the magnets are present at all the

temperatures likely to be experienced by an internal combustion engine mounted in a motor vehicle.

Embodiments of the present invention and examples of its effect, use and benefits will now be described, by way of illustration only, with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a perspective sketch showing an embodiment of the present invention connected between a carburettor air/fuel mixture outlet and the inlet manifold of an internal combustion engine.

Figure 2 is a vertical sectional view at 2-2 through the arrangement of Figure 1.

Figure 3 is a sectional view at 3-3 of Figure 2.

Figure 4 shows the individual components of one of the magnet assemblies used in the embodiment illustrated in Figures 1, 2 and 3.

Figure 5 illustrates two alternative constructions of the body members that have been used in implementations of the present invention.

Figure 6 is a partly schematic, partially sectional view of the application of the present invention to an engine having a carburettor with primary and secondary air/fuel mixture outlets.

Figure 7 is a sectional view at 7-7 of Figure 6.

Figure 8 is a partly schematic sectional view of an alternative embodiment of the present invention for use with a carburettor having primary and secondary air/fuel mixture outlets.

Figure 9 illustrates the equipment used in a university evaluation of the physical effect of the present invention on the droplet size distribution of an air/fuel mixture.

Figure 10 is a graph showing the measured droplet size of an air/fuel mixture, obtained using the equipment shown in Figure 9.

Detailed Description of the Illustrated Embodiments

The arrangement illustrated schematically in Figure 1 shows an embodiment of the present invention mounted between the air/fuel mixture outlet 10 of a carburettor and the inlet manifold 11 of an internal combustion engine. As shown in Figure 2, the carburettor has a butterfly valve 13, which is adjacent to the air/fuel mixture outlet and which, when opened fully, moves partly into the region below the outlet.

As shown particularly in Figure 2, the embodiment of the present invention comprises a body member 14 which defines an internal channel 15. When this embodiment is assembled in an engine as shown in Figure 1, the channel 15 provides a duct for the air/fuel mixture between the carburettor outlet 10 and the inlet manifold 11. The body member 14

may be made from aluminium, brass or any other suitable non-magnetic material.

The internal wall of the body member 14 is provided with a pair of inwardly extending steps 16 which are diametrically opposed with respect to the channel 15. A pair of magnet assemblies are positioned one on each of the steps 16, and are positively located in those positions by any suitable means (such as stops, locating keys, spring clips, clamps or the shaping of the internal walls of the body member 14).

Each magnet assembly comprises the components illustrated in Figure 4, namely a block or rod magnet 30 and a pair of flat ferromagnetic (for example, soft iron) pole pieces 31 and 32. The rod magnet 30 is magnetised across its faces 33 and 34, so that when the pole pieces 31 and 32 are brought into contact with the faces 33 and 34, respectively, of the magnet 30, the edges 31A and 32A of the pole pieces become the poles of the magnet assembly. The shape of the edges 31A and 32A is not critical. Normally the edges 31A and 32A will be rounded as shown in Figure 3 or flat as shown in Figure 2. The dimension w of the pole pieces 31 and 32 need only be a millimetre or so greater than the dimension b of the magnet 30 to establish the required magnet field structure of the resent invention. Normally the dimension b will be about 10 mm.

As indicated above, the magnet 30 must have a Curie temperature (the temperature at which the remanent magnetisation becomes zero) which is higher than the

maximum temperature likely to be experienced in the vicinity of the internal combustion engine. In a motor vehicle, this maximum temperature occurs shortly after the engine has been switched off after use, and is usually in the range of from 140°C to 160°C. The present inventor has successfully used rod magnets measuring 30 mm by 10 mm by 6 mm made from (a) a neodymium, iron and boron alloy having a Curie temperature of about 250°C, and (b) a cobalt and samarium alloy, having a Curie temperature of about 350°C. The former magnets, which had a magnet strength of 12,000 gauss, were obtained from Swift & Levic Magnets, of Sheffield, England. The latter magnets, which had a magnet strength of 10,500 gauss, were supplied by Hitachi Corporation, of Japan. Both types of magnets performed satisfactorily but the cobalt/samarium magnets are preferred because they have the higher Curie temperature.

The pole pieces 31 of the two magnet assemblies shown in Figures 1, 2 and 3 establish a magnetic field B1 in the channel 15, and the two pole pieces 32 establish a magnetic field B2. As shown in Figure 2, the lines of force of the magnetic field B1 are in the opposite direction to the lines of force of the magnetic field B2, but the lines of force of each field B1 and B2 are orthogonal to the direction of flow, through channel 15, of the air/fuel mixture leaving the carburettor outlet 10. Normally the spacing a between the two pole pieces 31 (and thus also between the two pole pieces 32) will be in the range from 10 mm to 20 mm, but this spacing may be varied to suit a particular engine and/or carburettor.

In the embodiment illustrated in Figure 2, the carburettor outlet 10 is provided with a flange 17 which is complementary to a flange 18 formed with or attached to the body member 14. The inclusion of a gasket 19 between the flanges 17 and 18 enables a gas-tight connection to be made between the carburettor outlet 10 and the body member 14 when the flanges 17 and 18 are clamped together by conventional means.

The connection between the body member 14 and the inlet manifold 11 is effected by making the lower region 14A of the body member 14 as a tubular structure of annular cross-section, with a groove 21 formed in its outer surface to receive an O-ring 22. The diameter of the circular cross-section of the strip of material which forms the O-ring 22 (that is, the diameter of each of the two sections shown by the reference numeral 22 in Figure 2) is such that, when the region 14A of the body member is inserted into a circular aperture 20 of the inlet manifold 11, a seal is established between the region 14A and the wall of the aperture 20 by the O-ring 22. A sealing compound (for example, a silicone sealing compound) may be used to facilitate the establishment of this seal. Since the inlet manifold of an internal combustion engine is normally kept at a relatively cool temperature, the O-ring 22 may be a conventional neoprene O-ring.

It should be apparent that any other suitable means of connecting the body member 14 to the carburettor outlet 10 and to the inlet manifold 11 in a gas-tight manner may be used instead of the arrangement illustrated in Figure 2.

In the arrangement illustrated in Figure 2, an external step 23 at the upper end of the tubular end region 14A of the body member ensures that the body member cannot be inserted into the inlet manifold to such an extent that the O-ring 22 is at least partially inside the wall of the inlet manifold. In other constructions of the body member 14, two of which are illustrated in Figure 5, the body member is provided with a pair of legs 25 which are screwed into threaded apertures in the base of the body member 14. The screw thread connection enables the length of the legs 25 projecting from the body member 14 to be adjusted so that when the legs 25 and the lower region of the body member 14 (with an O-ring in the groove 21) are inserted into the aperture 20 of the inlet manifold, the legs act as spacers when they come into contact with the inner face of the lower wall of the inlet manifold 11 opposite the aperture 20.

Many carburettors have a separate primary and secondary air/fuel mixture outlet. With such carburettors, it is convenient (but not essential) to adopt either the arrangement shown in Figures 6 and 7, or the arrangement illustrated in Figure 8.

The partly schematic, partly sectional arrangement of Figure 6 shows how a body member 44 containing two separate pairs of magnet assemblies is mounted between a carburettor 45 and the inlet manifold 11 of the internal combustion engine. The pairs of magnet assemblies provide the magnetic fields B1 and B2 for each of the carburettor

outlets 10. An air cleaner 46 is shown mounted on top of the carburettor 45 in Figure 6.

In the alternative arrangement for a twin-outlet carburettor, illustrated in Figure 8, a central magnet assembly, comprising rod magnet 80 and ferromagnetic pole pieces 81 and 82, is used to provide, with respective outer magnet assemblies as described above the magnetic fields B1 and B2 for the primary and secondary air/fuel mixture outlets of the carburettor.

Similar arrangements to those shown in Figures 7 and 8 may be used with a central fuel injection system, in which two jets of fuel are provided directly to the inlet manifold of the internal combustion engine.

If the strengths of the magnetic fields B1 and B2 are to be varied, the bar magnets are replaced with the pole pieces of electromagnets. The electromagnets are operated with varying DC currents through their windings.

The present invention has been tested with engines of various sizes. Details of some of the tests and evaluations of the invention are provided in the following examples.

Example 1

A General Motors Holden vehicle, a 1964 "EH" Model motor car, designed to be run on fuel containing tetraethyl-lead as an anti-knocking agent, was run on unleaded fuel over a period of nine weeks. In this way, the fuel tank was

effectively washed with unleaded petrol ten times. At the end of this "washing" exercise, the fuel supplied to the engine was effectively lead-free.

With the first prototype equipment of the present invention mounted between the carburettor and the inlet manifold of the 6-cylinder engine, and with the magnet assembly pole pieces separated by 20 mm, the engine ran smoothly at all times. An exhaust gas analysis of the engine fitted with the first prototype of the invention showed that the requirements of Australian Design Rule No 37/00 had been met. Even when operated under load, the engine exhibited no trace of knocking. It was concluded that essentially complete combustion of the unleaded petrol had been achieved.

Example 2

A Ford Motor Company vehicle, a 1970 Model "Cortina 440" motor car, was used in further tests of the present invention. No emission control equipment was fitted to the 4-cylinder, 1500 cc engine of this vehicle, which was run for nine months in the Canberra region of Australia using unleaded petrol only as the fuel. The cylinders of this engine had compression readings before this nine-months period of 965, 914, 793 and 965 kPa (corresponding to 140, 137, 115 and 140 p.s.i., respectively), and those compression figures were essentially unchanged at the end of this nine-months period.

Tests were then made of the on-road performance and the fuel usage, and the exhaust gas of the vehicle was

analysed, with and without a second prototype unit of the present invention attached to the engine. In this second prototype of the invention, the pole pieces establishing each magnetic field were spaced apart a distance of 7 mm and, to maintain a smooth flow of the air/fuel mixture, a generally conical taper to the gap between the pole pieces was established. The taper was created in a plate having a thickness of 9 mm, mounted immediately above the upper-most pair of pole pieces in the unit of the present invention. Tests with and without the taper present showed an increase of 5 per cent in the horsepower generated by the engine when the conical taper was included.

The road tests showed that the engine operated smoothly with the second prototype unit attached, and with an apparently improved fuel economy. The exhaust gas analysis measurements were effected with the assistance of engineers from the National Roads and Motorists' Association Limited (NRMA). The cooperation of the NRMA in this analysis, and in the further exhaust gas testing reported in other Examples, is hereby acknowledged with gratitude. Table 1 summarises the results obtained from the exhaust gas analysis measurements.

Table 1
"Cortina" Exhaust Gas Analyses

Parameter measured	Without present invention	With present invention attached	Increase (I) or Decreased (D) in measured parameter
Hydrocarbon emission	1120 ppm	186 ppm	(D) 83%
Carbon monoxide content	6.56%	1.83%	(D) 72%
Oxides of nitrogen content	3.74%	1.56%	(D) 58%
Carbon dioxide content	6.39%	13.08%	(I) 52.7%

These figures clearly illustrate the significant improvement in combustion that was achieved when the present invention was fitted to the engine of this vehicle.

Example 3

The vehicle used in this example was a Mitsubishi Motors "MAGNA TN" motor car, manufactured in 1987, and fitted with an automatic gearbox. The 2.6 litre, 4-cylinder engine of this vehicle was equipped with all the normal emission control equipment, including a catalytic converter. With the assistance of NRMA engineers, measurements of the exhaust gas composition of the engine were made (a) with

the catalytic converter present and the present invention not fitted to the engine of the vehicle; (b) with the catalytic converter removed and the present invention not fitted to the engine; and (c) with the catalytic converter removed and with a unit of the present invention, constructed as shown in Figure 2, fitted between the carburettor and the inlet manifold of the engine. The results achieved are shown in Table 2.

Table 2
"Magna" Exhaust Gas Analyses

Parameter measured	Engine RPM (average of tests)	Normal emission control equipment fitted	Catalytic converter removed; present invention not fitted	Catalytic converter removed; present invention fitted
Hydrocarbon content	1133	2 ppm	107 ppm	20 ppm
	1974	4 ppm	103 ppm	40 ppm
	3035	7 ppm	61 ppm	20 ppm
Carbon monoxide content	1133	0.08%	3.52%	0.11%
	1974	0.29%	3.52%	1.47%
	3035	0.54%	1.45%	0.12%
Oxides of nitrogen content	1133	0.97%	3.83%	1.79%
	1974	0.92%	3.53%	0.61%
	3035	0.22%	1.41%	1.80%
Carbon dioxide content	1133	14.3%	9.79%	13.8%
	1974	14.2%	10.1%	13.7%
	3035	14.6%	13.4%	13.7%

It was subsequently found that when these measurements were made, the carburettor jet was too large for this engine, with the result that the engine was running "rich". It is believed that, had a smaller carburettor jet been fitted, the present invention would have reduced, substantially, at least the hydrocarbon content of the exhaust gas.

Two road tests were made with this vehicle, after its engine had been fitted with the second prototype of this invention. Each road test involved a round trip of 199.7 km under essentially identical conditions, including 16 km of city traffic. The vehicle was driven in the same manner in each test, in the presence of two observers (one a director of the Institute of Automotive and Mechanical Engineers of Australia, the other the manager of the service department of the distributors of the vehicle in the Australian Capital Territory). The average fuel consumption was 17.44 litres. The expected fuel consumption for such a trip, based on figures published by NRMA for the same model vehicle, was 25.36 litres.

Example 4

The celebrated Australian artist Pro Hart owns two substantially identical Rolls Royce sedan cars, built in 1956. Each car has an engine of capacity 6.75 litres, to which fuel is supplied via a pair of carburettors. Experience over years of use of these motor vehicles shows that they have essentially identical fuel economies. Two units of the present invention, constructed as shown in Figures 2, 3 and 4 and with the pole pieces of the two magnet assemblies separated by 10 mm, were fitted between

respective carburettor outlets and the inlet manifold of one of the engines.

In a series of six test runs of each vehicle, driven in a similar manner over the same test route, the vehicle fitted with the unmodified Rolls Royce engine had an average fuel consumption rate of 25.5 litres per 100 kilometres. In contrast to this, the vehicle fitted with the two units of the present invention had an average fuel consumption rate of 13.0 litres per 100 kilometres. Subsequent analysis of the carbon monoxide content of the exhausts from these vehicles showed that the exhaust of the unmodified Rolls Royce engine had a carbon monoxide content of 9.0 per cent, whereas the engine equipped with the two units of the present invention had zero carbon monoxide in its exhaust gas.

Example 5

A unit of the present invention was evaluated in an engine test bed at Goodman Racing Developments, Sydney, Australia. The evaluation involved running a Ford 1600 cc, Formula 4, Cross-Flow racing engine in the test bed both with and without the present invention fitted to the engine. The test bed results of the brake horsepower developed by the engine, with similar loads and similar other operating conditions, are shown in Table 3.

Table 3

Power Comparisons - 1600 cc Ford Racing Engine

Engine RPM	Average Horsepower Developed Without Present Invention	Average Horsepower Developed With Present Invention	Difference in Horsepower Developed
1500	25.03	24.12	- 0.91
2000	28.83	29.58	+ 0.75
2500	40.05	41.27	+ 1.22
3000	55.10	56.28	+ 1.18
3500	65.41	67.53	+ 2.34
4000	76.46	78.04	+ 1.58
4500	86.02	86.34	+ 0.32
5000	93.98	93.80	- 0.18
5500	99.27	99.64	+ 0.37
6000	101.88	101.62	- 0.26
6500	102.04	101.76	- 0.31

It will be seen that at the engine speeds most commonly used - in the range of from 2500 revolutions per minute (RPM) to 4000 RPM - there was an improvement in the horsepower developed by this engine.

Exhaust gas analyses of the engine produced the results shown in Table 4, demonstrating once more that improved combustion is achieved using the present invention.

Table 4

Exhaust gas analysis of 1600 cc Ford Racing Engine

Engine RPM	Parameter Measured	Without Present Invention Fitted	With Present Invention Fitted
3000	Carbon	4.60%	4.32%
4000	monoxide	3.41%	2.14%
5000	content	1.90%	0.70%
3000	Hydrocarbon	910 ppm	145 ppm
4000	content	545 ppm	40 ppm
5000		515 ppm	5 ppm

Example 6

Lake Tuggeranong College in the Australian Capital Territory built two essentially identical vehicles, each powered by a 50 cc Honda engine, for use in the 1992 "Shell Mileage Marathon" held at the Amaroo Park Raceway, near Sydney, Australia. The engine of one of these vehicles was fitted with a unit of the present invention, in which the spacing between the pole pieces to establish the magnetic fields B1 and B2 was 1.7 mm.

In the "Shell Mileage Marathon", the vehicle equipped with the present invention took first place in Class D (Schools - commuter class - two persons in the vehicle) with a fuel consumption figure of 559.50 miles per gallon. The vehicle not equipped with the present invention was not

included in the top seventeen vehicles in Class D, meaning that its fuel consumption was less than 164.91 miles per gallon.

The performance in Class D of the vehicle equipped with the present invention was sufficient to give this vehicle first place, outright, in the Commuter Class, as its fuel consumption was better than any other "commuter" vehicle in the competition (some of which were vehicles entered by commercial automotive engineering organisations).

Example 7

An evaluation of the physical effect on the structure of the air/fuel mixture of the sequentially applied opposed magnetic fields was carried out by Prof B Luther-Davies and Dr A V Rode at the Laser Physics Centre of The Australian National University (Canberra, Australia). The equipment used for this evaluation is illustrated in Figure 9.

As shown in Figure 9, a laser beam 91, generated by a laser 90, was directed through an input window 92 and an output window 93 of a chamber attached to the inlet manifold of an internal combustion engine. The chamber had four ports, two of which contained the input window 92 and the output window 93. Another port 94 was connected to the inlet manifold of the engine. The fourth port 95 was connected directly to the output of a unit of the present invention 100, mounted underneath the SU carburettor 96 normally used to supply an air/fuel mixture to the engine.

The droplet structure of the air/fuel mixture was measured while the engine was operating, using a laser scattering technique (a) with two opposed magnetic fields in the unit 100 and (b) using a duplicated form of the present invention, with which the air/fuel mixture was subjected to four magnetic fields, in alternating opposed directions. The resultant particle size distribution for the two magnetic fields unit of the invention is shown by the solid curve in Figure 10. The dashed curve illustrates the departure from this droplet size distribution when four magnetic fields were applied to the air/fuel mixture. The technique used did not permit recordal of droplets having a diameter less than 3 microns.

This evaluation, the results of which were reported in <u>The ANU Reporter</u>, volume 29, No 12, of 12 August 1992, showed clearly that (1) the present invention acts to strongly reduce the number of large droplets in the air/fuel mixture and increase the number of small droplets, and (2) the change in the fuel droplet size distribution is large enough to significantly affect the combustion of the fuel.

Example 8

A further series of road tests and exhaust gas analyses were performed with the Mitsubishi "Magna" vehicle used in Example 3, equipped with a unit of the present invention. Again, NRMA engineers assisted in the tests and analyses.

With full polution control equipment fitted to the vehicle, the road test showed that at a constant speed of 60 km per hour, the fuel consumption was 14.3 litres per 100

kilometres (19.68 miles per gallon), and at a constant speed of 100 km per hour, the fuel consumption was 12.7 litres per 100 kilometres (22.22 mpg). With the catalytic converter removed, and with the unit of the present invention attached, the fuel consumption figures at constant speeds were measured at (a) 60 km per hour - 9.32 litres per 100 kilometres or 30.24 mpg; (b) 80 km per hour - 6.64 litres per 100 kilometres or 42.47 mpg; amd (c) 100 km per hour - 7.75 litres per 100 kilometres or 36.26 mpg.

The exhaust gas analysis, performed at the ACT Government Vehicle Testing Station at Dickson in the Australian Capital Territory, conducted with the catalytic converter removed and the present invention fitted to the engine, gave the following average readings when the engine was idled at 900 RPM (the maximum permissible values are shown in parentheses after each reading): (a) hydrocarbon content: 68 ppm (350 ppm); (b) carbon monoxide content: 0.7 per cent (3.5 per cent). Thus, set to idle at 900 RPM, this vehicle complied with the emission control requirements of Australian Design Rule No 37/00 without the need for a catalytic converter.

Reducing the idle speed to 600 RPM, at which rate the engine did not idle smoothly, resulted in an increase of the hydrocarbon content of the exhaust gas to 178 ppm (still well below the maximum permissible level) and an increase in the carbon monoxide content to 3.74 per cent (slightly above the maximum permissible level of 3.50 per cent).

These examples illustrate that the use of the present invention improves combustion in an internal combustion engine, to reduce pollutants in the exhaust gas of the engine and also to improve the fuel economy of the engine. It has also been found that use of the present invention with unleaded petrol can also reduce the production of hydrogen sulphide in the exhaust gas of an internal combustion engine.

It will be clear to automotive engineers that although specific embodiments of the present invention have been illustrated in the accompanying drawings and described above, variations to, and modifications of, those embodiments may be made without departing from the present inventive concept. Among such modifications and variations are the use of the present invention with "leaded" petrol, and possibly with two-stroke engines and the internal combustion engines used to power aircraft (neither of these last two uses has yet been tested).

CLAIMS

1. A method of treating an air/fuel mixture (consisting of droplets of fuel in suspension in the air) being supplied to an internal combustion engine to reduce the size of the fuel droplets in the mixture comprising the steps of
   (a) subjecting the air/fuel mixture to a first magnetic field which has its magnetic lines of force extending substantially transverse the direction of flow of the air/fuel mixture, and
   (b) subsequently subjecting the air/fuel mixture to a second magnetic field which has its magnetic lines of force substantially transverse the direction of flow of the air/fuel mixture and also substantially in the opposite direction to the lines of force of the first magnetic field, said pair of first and second magnetic fields being spaced apart from each other.

2. A method as defined in claim 1, in which said air/fuel mixture is generated by a carburettor.

3. A method as defined by claim 1, in which said air/fuel mixture is generated by a central fuel injection system.

4. A method as defined in any preceding claim, in which said first magnetic field and said second magnetic field have a constant value.

5. A method as defined in claim 1, claim 2 or claim 3, in which said first magnetic field and said second magnetic field are established by an electromagnet, and the strengths of said first and second magnetic fields are varied by changing the electric current in the windings of the electromagnet.

6. Apparatus for applying a pair of magnetic fields to an air/fuel mixture being supplied to an internal combustion engine, said apparatus comprising:
   (a) a body member having a channel extending therethrough, said body member being adapted to be mounted on the engine to form part of the flow path of the air/fuel mixture; and
   (b) a pair of magnet assemblies mounted within said body member in diametrically opposed relationship to the channel extending therethrough, said magnet assemblies producing (i) a first magnetic field having its lines of force extending in a direction which is transverse the channel and orthogonal to the flow-through direction in said channel of said air/fuel mixture, and (ii) a second magnetic field having its lines of force extending in a direction which is transverse the channel and opposite to the direction of the lines of force of said first magnetic field.

7. Apparatus for applying a pair of magnetic fields to an air/fuel mixture being supplied to an internal combustion engine through a pair of closely separated channels, said apparatus comprising:

(a) a body member having a pair of channels extending therethrough, said body member being adapted to be mounted on the inlet manifold of the engine with said channels forming part of the flow path of the air/fuel mixture; and

(b) a pair of magnet assemblies mounted within said body member in diametrically opposed relationship in each of said channels, each of said magnet assemblies producing (i) a first magnetic field having its lines of force extending in a direction which is transverse its associated channel and orthogonal to the flow-through direction in its associated channel of said air/fuel mixture, and (ii) a second magnetic field having its lines of force extending in a direction which is transverse its associated channel and opposite to the direction of the lines of force of said first magnetic field.

8. Apparatus as defined in claim 6 or claim 7, in which each of said magnet assemblies comprises a rod magnet of rectangular cross-section having

(1) a pair of opposed, elongate faces, said rod magnet being magnetised across said opposed, elongate faces; and

(2) a pair of generally flat, elongated, ferromagnetic pole pieces, each of said pole pieces having a width which is greater than the width of the elongate faces of the rod magnet, said flat pole pieces being positioned with a face thereof in contact with a respective one of

the elongate faces of the bar magnet, and with a corresponding edge region thereof projecting behind an elongate edge of the elongate faces of the bar magnet, to thereby form a pair of poles of magnet assembly.

9. Apparatus as defined in claim 8 when appended to claim 7, in which, in each of said channels, one of the magnet assemblies is part of a common magnet assembly extending between said channels.

10. Apparatus as defined in claim 8 or claim 9, in which each of said projecting edge regions has a rounded edge surface.

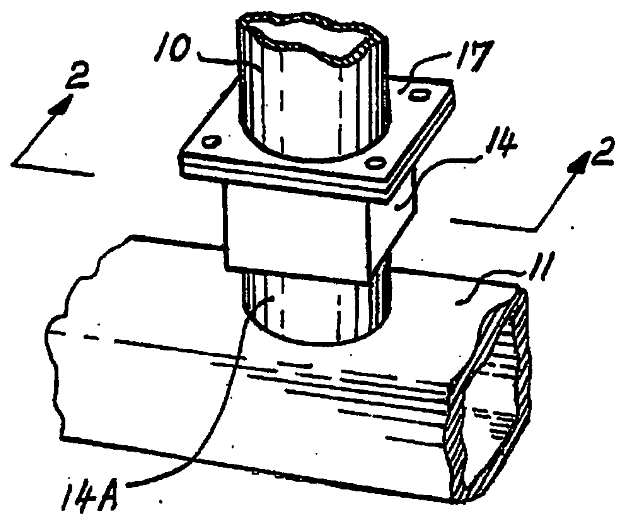
11. Apparatus as defined in claim 6 or claim 7, in which each of said magnet assemblies is an electromagnet.

12. Apparatus as defined in any one of claims 6 to 11, in which said air/fuel mixture is created by a carburettor and said apparatus is adapted to be connected to the outlet or outlets of said carburettor.

13. Apparatus as defined in any one of claims 6 to 11, in which said air/fuel mixture is created by a central fuel injector and said apparatus is adapted to be connected to the outlet or outlets of said central fuel injector.

14. A method of treating an air/fuel mixture being supplied to an internal combustion engine, substantially as hereinbefore described with reference to Figures 1 to 8 of the accompanying drawings.

15. Apparatus for applying a pair of magnetic fields to an air/fuel mixture being supplied to an internal combustion engine, substantially as hereinbefore described with reference to Figures 1 to 8 of the accompanying drawings.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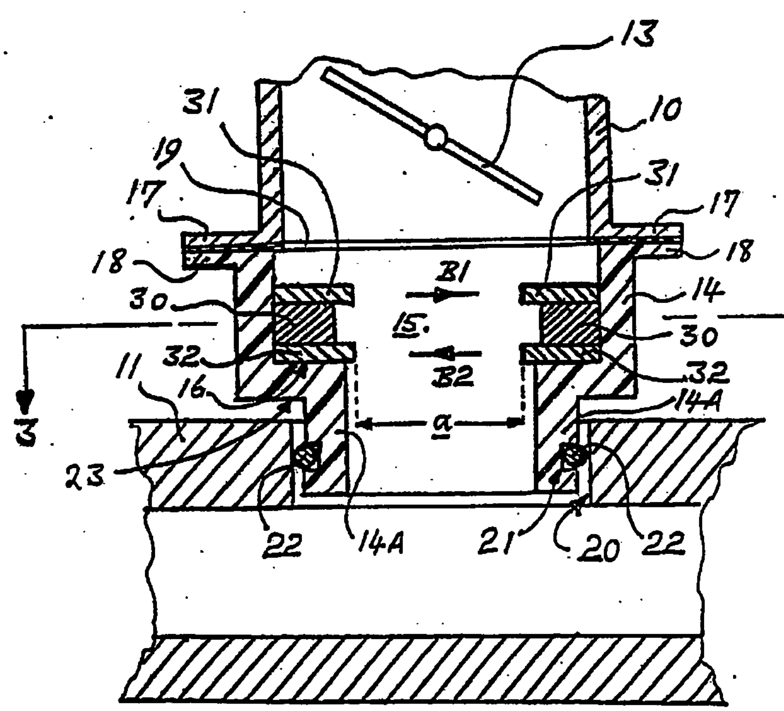
14A

FIG. 1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B2
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11
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14A
3
a
3
23
22
14A
21
20
22

FIG. 2

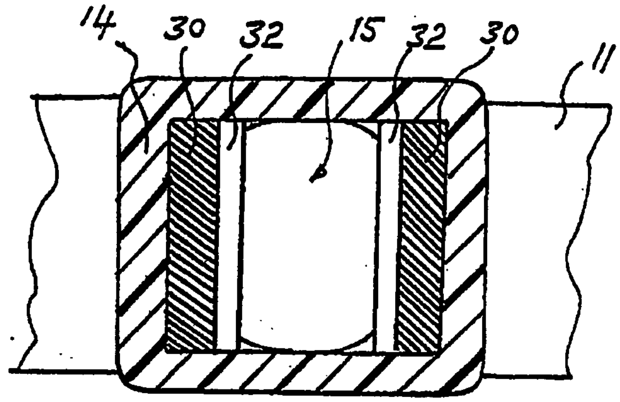


FIG. 3

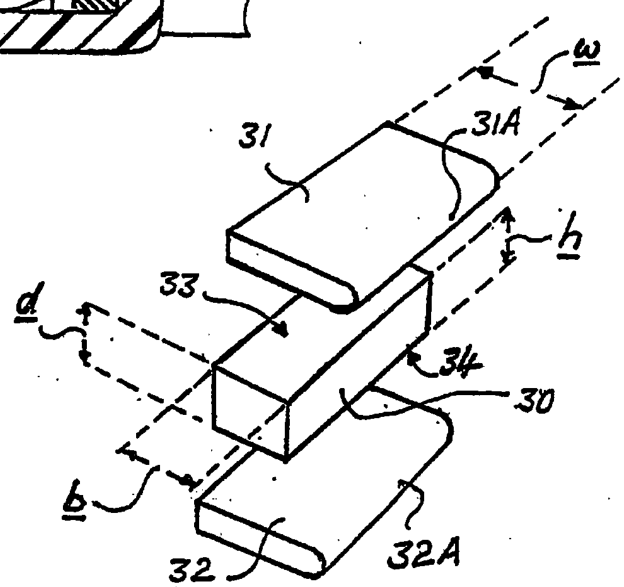


FIG. 4

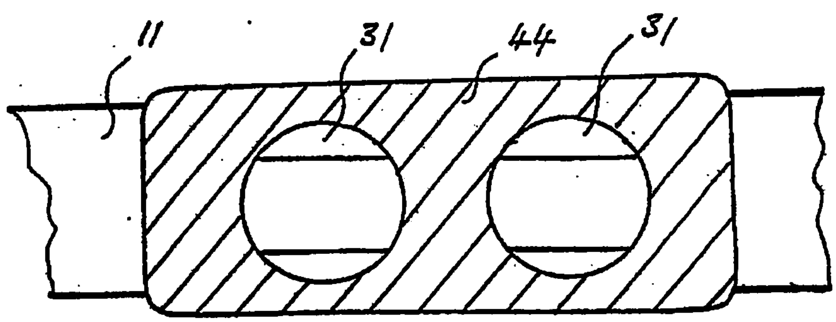


FIG. 7

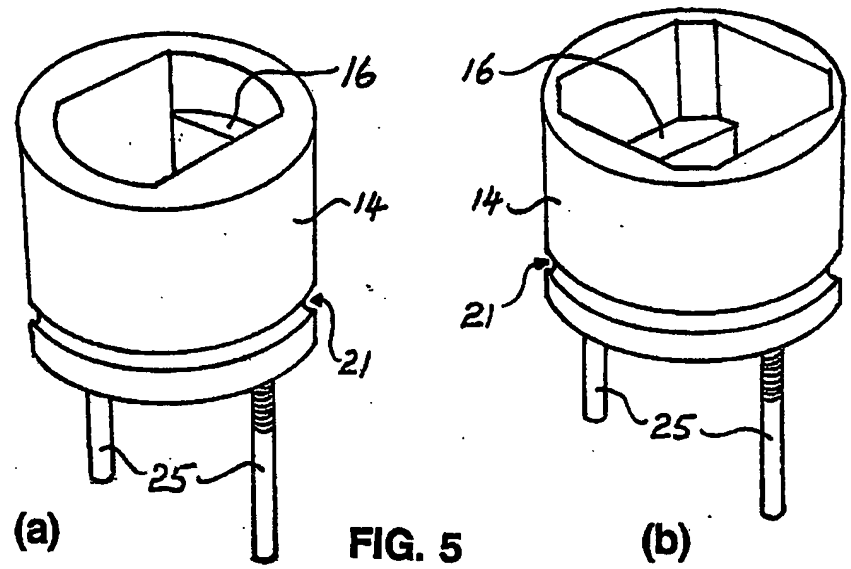

16
14
21
25
(a)
16
14
21
25
(b)

FIG. 5

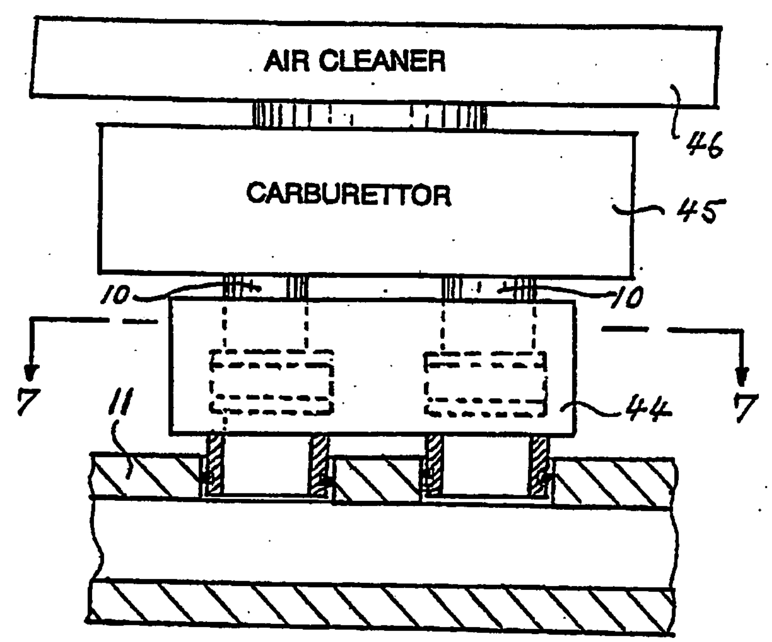
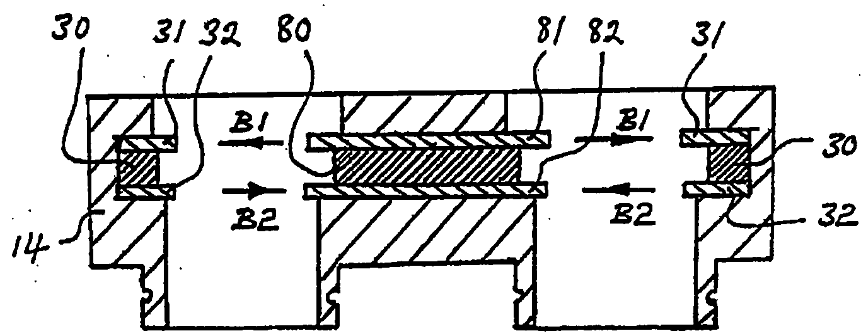

AIR CLEANER
46
CARBURETTOR
45
10
10
7
11
44
7

FIG. 6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81
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B1
B1
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B2
B2
32
14

FIG. 8

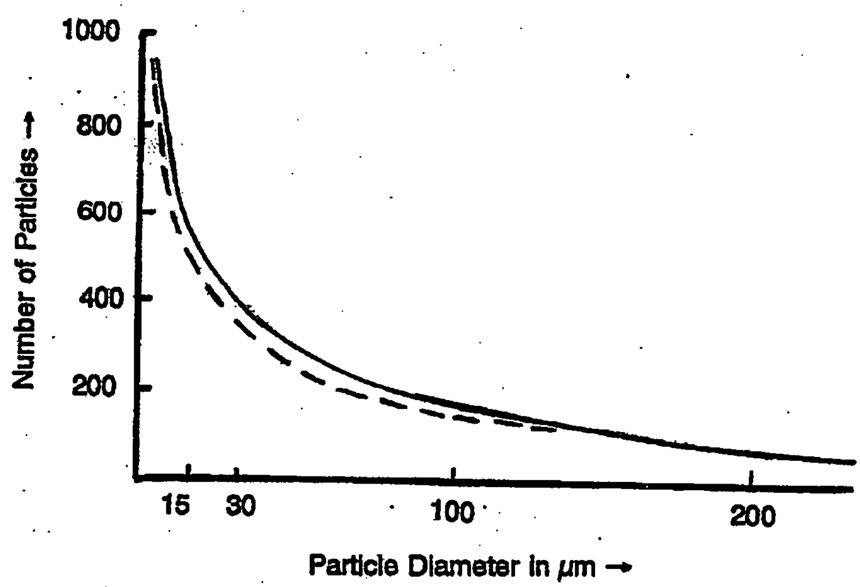
1000
800
600
400
200
Number of Particles →
15
30
100
200
Particle Diameter in µm →

FIG. 10

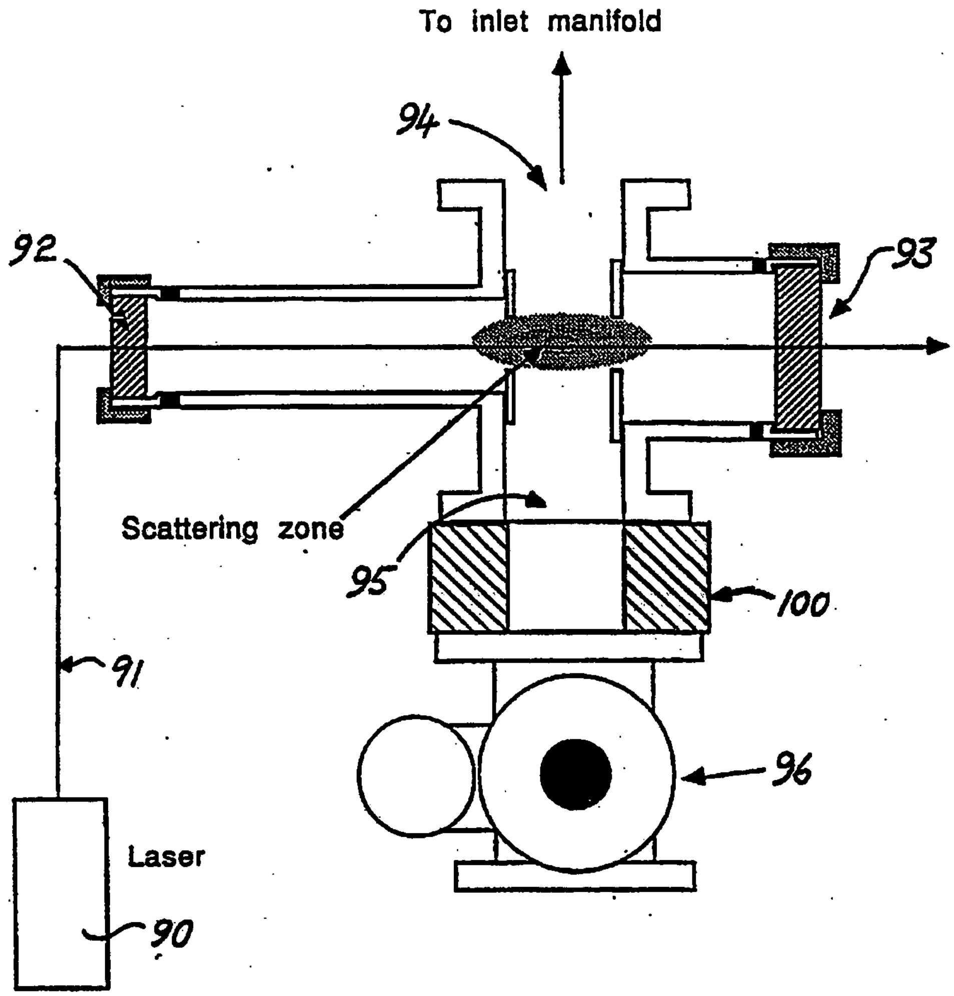
To inlet manifold
94
92
93
Scattering zone
95
100
91
96
Laser
90

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU93/00183

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[5] F02M 27/04, F02B 51/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: F02M 27/04, F02B 51/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X Y	Patent Abstracts of Japan, M6, page 29, JP,A,55-14471 (MORINO) 31 January 1980 (31.01.80) abstract	1-13
X Y	EP,A,0473133 (GEKKO INTERNATIONAL, INC.) 4 March 1992 (04.03.92) column 1, lines 29-38; column 3, lines 44-55 and figures 4-5	1-13
X Y	EP,A,0073077 (S.B.H. TRADING S.A.) 2 March 1983 (02.03.83) page 2, line 8 - page 3, line 7 and figures 1-2	1-13

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 June 1993 (30.06.93)	7 JULY 1993 (7.07.93)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. (06) 2853929	Authorized officer C.M. WYATT Telephone No. (06) 2832538

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
Y	US,A,4605523 (SMILLIE) 12 August 1986 (12.08.86) column 2, lines 16-48 and figures 1-2 - mist aspect	1,6-7
A	AU,A,57234/90 (WRIBRO LIMITED) 29 November 1990 (29.11.90) page 4, lines 12-18 and figure 1, reference items 30 and 32	
A	CA,A,1092917 (DALUPAN) 6 January 1981 (06.01.81) page 5, line 24 - page 8, line 4 and figures 1, 4 and 5	
A	GB,A,2122253 (AKAI) 11 January 1984 (11.01.84) figure 1 and abstract	
A	EP,A,0434558 (FOREST SCIENTIFIC RESEARCH LIMITED) 26 June 1991 (26.06.91) page 3, lines 16-22; page 6, lines 44-48 and figures 1 and 8	
A	AU,A,68580/91 (EAGLE RESEARCH AND DEVELOPMENT INC.) 19 March 1992 (19.03.92) page 6, lines 9-15; page 7, lines 28-30 and figures 1-6	
A	EP,A,0501589 (HANDELSBURO "ZWOLLE") 2 September 1992 (02.09.92) column 3, lines 14-26 and column 4, lines 14-21	
A	US,A,4711271 (WEISENBARGER et al) 8 December 1987 (08.12.87) figure 5	
A	US,A,4188296 (FUJITA) 12 February 1980 (12.02.80) column 4, lines 33-43 and figures 1-2	
A	Patent Abstracts of Japan, M609, page 28, JP,A,62-38865 (MIZUKOSHI) abstract	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	473133	BR	9103701	CA	2050025	US	5127385
EP	73077	CH	644934				
AU	57234/90	EP	399801	NO	914598	WO	9014516
		ZA	9004037				
EP	434558	AU	68279/90	BR	9006481	CA	2032574
		CN	1052611	JP	4148682	NO	905474
		NZ	231876	PT	96216	ZA	9010239
AU	68580/91	US	5129382				
US	4188296	JP	53085922	DE	2800790	SE	7800142

END OF ANNEX